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Utilization of Low NOx Coal Combustion By-Products

Quarterly Report
January 1 - March 31, 1996

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PROJECT SUMMARY - SIXTH QUARTER

January 1, 1996 through March 31, 1996

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TASK 1.0 - TEST PLAN

This task has been completed.

TASK 2.0 - LABORATORY CHARACTERIZATION

Task 2.1 - Sample Collection

No new samples were received this quarter. We do not expect to collect any additional samples for this project.

Task 2.2 - Material Characterization

Characterization and analytical activities focused on the various utilization tasks and are detailed in the specific task descriptions. Characterization of the Consumers Power Company (CPC) ash was conducted. The specific gravity of the as-received ash was 2.149 gm/cc. The as-received ash contained 0.63% by weight cenospheres and 3.66% by weight magnetic material. The size distribution and LOI by size analysis for the as-received CPC ash is given in Table 1. The Microtrac analysis of the -400 mesh fraction of the CPC ash is given in Table 2.

Table 1. Consumers Power Co. As-received Ash - Size Distribution and LOI by Size

Tyler Mesh		% Weight		% LOI		Distribution	
	Wt. (g)	individual	cumulative	individual	cumulative	individual	cumulative
+65	0.0	0.00	0.00	0.0	0.00	0.0	0.00
+100	6.0	5.51	5.51	51.68	51.68	43.37	43.37
+150	4.2	3.86	9.38	13.10	35.79	7.70	51.07
+200	5.2	4.78	14.15	9.57	26.93	6.97	58.04
+270	3.8	3.49	17.65	7.37	23.06	3.92	61.96
+325	4.8	4.41	22.06	6.54	19.76	4.39	66.35
+400	4.6	4.23	26.29	5.16	17.41	3.32	69.68
-400	80.2	73.71	100.0	2.70	6.57	30.31	100.0
head	108.8			6.57			

Table 2. Consumers Power Company As-received Ash - Microtrac Analysis		
Channel	Cumulative	Volume
62	100.0	1.6
44	98.4	7.4
31	91.1	11.4
22	79.6	13.4
16	66.3	15.1
11	51.2	14.3
7.8	36.9	12.3
5.5	24.6	8.9
3.9	15.7	6.0
2.8	9.7	5.6
1.9	4.1	2.4
1.4	1.6	1.4
0.9	0.2	0.2

Task 2.3 - Laboratory Testing of Ash Processing Operations

One laboratory test was conducted using CPC ash. Standard test conditions were used, resulting in a clean ash with a carbon content of 0.23%.

TASK 3.0 - PILOT PLANT TESTING

Eight pilot plant runs were conducted during this quarter. Two runs served to generate clean DE2 ash. Three runs each were conducted using AEP and NPC ash. These runs generated clean ash for the block and brick testing. After the clean ash was dried, three sets of samples, one of each ash type, were packaged in drums and shipped to Alpena Community College for the block and brick testing.

TASK 4.0 - PRODUCT TESTING

Activities are underway in all five subtasks.

Task 4.1 - Concrete Testing

The compressive strength testing of the concrete samples is complete. Analysis of the data is in progress.

Task 4.2 - Concrete Block/Brick

Concrete blocks and bricks were formed at Alpena Community College in Alpena, Michigan, March 17-20, 1996. Prior to the testing, a test plan was developed and discussions were held regarding the manufacturing process, which included the effects of the main process parameters on properties, and quality control. A series of experiments, using three different sources of both as-received and cleaned fly ash, was conducted to determine the influence of ash type and the beneficiation process on block quality. Table 3 describes the test plan for block manufacture. The test plan for manufacturing brick with fly ash is given in Table 4. Both the block and brick were also formed without fly ash, for comparison.

The equipment used in this task was made by the Besser Company. Computers were utilized to control the block and brick forming process. The main process variables influencing product quality are blending time, water to cement ratio, feed time, and finish time. These were controlled during the testing to ensure good quality blocks and bricks.

After manufacturing, physical and mechanical properties of the block and brick are being tested. This work is continuing at Alpena until mid May. Physical property tests include density, moisture content, absorption, and dry shrinkage. Mechanical property tests include one, seven, fourteen, and 28 day gross compressive strength and impact strength.

Task 4.3 - Plastic Fillers

During this reporting period, injection molding of tensile test specimens from fifteen fly ash and polymer compounds. The polymer compounds tested were polypropylene, low density polyethylene, and high density polyethylene, with five loading levels of fine AEP clean ash. For comparison, five kg of commercial $CaCO_3$ filler was purchased and used to prepare compounds with the same three polymers at the same loading levels as the fly ash tests. These compounds were also injection-molded to produce tensile test specimens.

Mechanical property tests on these specimens are underway, using an Instron mechanical testing machine. These tests will be completed during the next quarter.

Table 3. Test Plan for Block Manufacture

Batch	Fly Ash Type	Amount of cement replaced by fly ash (weight %)
1	As-received Class F	20
2	As-received Class C	20
3	As-received Class F/C	20
4	Clean Class F	15
5	Clean Class C	15
6	Clean Class F/C	15
7	Clean Class F	20
8	Clean Class C	20
9	Clean Class F/C	20
10	Clean Class F	30
11	Clean Class C	30
12	Clean Class F/C	30
13	No fly ash	0

Notes:
1. Normal weight blocks (8 x 8 x 6 with 2 hollow cores) are to be made in this experiment.
2. Each batch will manufacture 68 to 72 blocks.
3. After the blocks are fabricated, they will be low-pressure-steam cured at 165°F for 12 hours.
4. The cured blocks will be stored at room temperature and tested following ASTM standards.

Table 4. Test Plan for Brick Manufacture

Batch	Fly Ash Type	Amount of cement replaced by fly ash (weight)
1	As-received Class F/C	20
2	Clean Class F/C	20
3	No fly ash	0

Notes:
1. Normal weight bricks are to be made in this experiment.
2. Each batch will manufacture 68 to 72 bricks.
3. After the bricks are fabricated, they will be low-pressure-steam cured at 165°F for 12 hours.
4. The cured bricks will be stored at room temperature and tested following ASTM standards.

Task 4.4 - Activated Carbon

A test apparatus was fabricated for activating fly ash carbon. A preliminary test was run to check the suitability of this system. The resultant carbon will be evaluated to determine the adsorption properties such as BET surface area, iodine number, and molasses number.

The system consists of an activation bed, a heating furnace, and a gas-feeding unit. The activation bed is vertical and heated by the heating furnace. The temperature of the bed can be adjusted by the furnace controller. When steam is used as the activation gas, a syringe pump is used to feed water to the bed. The water is evaporated at high bed-temperatures, producing steam. The flow rate of steam is then obtained based on the water volume pumped to the bed and the bed temperature. When CO_2 is used, it is fed directly to the bed from a CO_2 gas cylinder through a pressure reducer.

The preliminary test used steam as the activation agent. The carbon tested was a +100 mesh size fraction sample from AEP fly ash. Since the temperature control of the carbon bed failed during the test, no activation was expected. Measurements show that the BET surface area of the carbon was 27 m^2 before activation and 26 m^2 after activation, which is within the instrumental error of measurement.

The future plan includes the following:

- Find the appropriate techniques to determine the effect of activation. The candidates may be BET method and adsorption isotherms of various adsorbents;
- Find a better way to control bed temperatures;
- Test CO_2 as activation agent.

Task 4.5 - Metal Matrix Composites

Optimization of the heat treatment procedures is continuing using 2124 Al / fly ash composite material. This alloy replaces the 6092 Al alloy that was tested previously. In addition, efforts are underway to locate a company to conduct wear testing on the composite. Tensile testing will also be conducted on the material.

Preliminary tests were conducted using iron powder and fly ash. The sample with 10 v/o% fly ash worked well, however, 20 v/o would not hold together when pressed. The 10% v/o fly ash sample was sintered to 92% density. A fly ash / glass composite was also tested. The glass used is part of a project sponsored by the Michigan Department of Natural Resources Solid Waste Alternatives Program (SWAP) to study the utilization of waste glass (project number MDRD-1-31-40014). The highest fly ash loading that could be formed was 30%. Composites of both 75 v/o% fly ash and 50% v/o% fly ash were tested, neither would compact.

TASK 5.0 - MARKET AND ECONOMIC ANALYSIS

Plastic Fillers

Samples of cleaned ash from several utilities were sent to The R. J. Marshall Company for evaluation as plastic fillers. All samples were found to be acceptable if properly blended with other standard materials. Such blending is standard practice to obtain filler mixtures with acceptable properties such as oil adsorption (a measure of undesirable resin adsorption), density, and particle size.

The one ton cleaned ash sample previously mentioned for The R. J. Marshall Company will be provided once it is determined which ash is likely to be the basis for the first beneficiation plant. The economics of ash disposal indicate an eastern utility is the most likely such candidate.

Activated Carbon and Carbon Black

The release of a long awaited EPA report on mercury emissions from coal burning electric utilities has been further delayed, from mid January until mid April. The report is anticipated to be the basis for the regulation of mercury emissions. In the meantime, the use of injected carbon to control mercury, especially in Europe, continues. Additional information indicates carbon is also useful to control dioxins.

Laboratory work continues on the effectiveness of fly ash carbon to control mercury and it may be desirable to extend the work to include organics such as dioxins.

Market Research and Development

The ultimate objective of this project is to reduce the beneficiation technology to practice. One utility that has participated in the project is contemplating such an investment. Before that occurs, however, it is necessary to confirm the existence of markets for various beneficiated project streams. One of the key areas, from this perspective, is the lightweight aggregate (LWA) market. This is a market previously served by an internal LWA plant. The current market potential for the product is unknown but of extreme interest because of its potential to consume large quantities of cleaned ash.

A market research project is being developed to be carried out at the utility's expense. The objective would be to estimate the demand for LWA from fly ash in a major metropolitan area. Major players such as suppliers, users, specifiers, and trade association representatives would be interviewed. The information gathered will be presented in a manner to complement the capital and operating costs of a fly ash beneficiation plant and a LWA plant. This will facilitate the investment analysis associated with a new LWA facility.